**Title Page:**

Efficient Natural Noise Removal in Real Time Images using Novel Kalman Filter Compared with Mean Filter for Accuracy Improvement

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**Keywords:** Real-time Images, Novel Kalman Filter, Mean Filter, Noise Detection Accuracy Value, Noise Elimination, *environment*

**ABSTRACT**

**Aim :**This study's main objective is to enhance noise identification and environment noise reduction in real-time images utilizing novel Kalman filters for effective analysis and comparison with the widely used Mean Filter.  **Materials and Methods**: The system is designed to remove the noises from real Time images using Novel Kalman Filters and Mean filters with sample size of 110 the g-power value of 0.8. The Real Time image dataset is used for investigational work in this research Novel Kalman Filter is executed using the MATLAB image processing tool. **Results and Discussion**: The accuracy value of the novel Novel Kalman Filter is compared with the current Mean Filter based on simulation results. The accuracy value of the suggested novel Novel Kalman Filter exceeds the current mean filter with a significant improvement (91.57% Vs 87.91%).The difference between the two groups is statistically significant, as shown by the p value of 0.005 (p0.05). **Conclusion:** In the subject of Real Time image evaluations and discoveries, this proposed research effort on Novel Kalman Filters argues that it is superior to the currently used Mean filter.

**Keywords:** Real-time Pictures, Novel Kalman Filter, Mean Filter, Accuracy Value, MATLAB Software, Noise Elimination , *Environment*.

**INTRODUCTION**

In the field of image processing, image filtering is currently a hot topic for research. Despite several research projects in various sectors, Image filtering distinguishes out due to its unique recognition . [(Bar-Shalom, Rong Li, and Kirubarajan 2001)](https://paperpile.com/c/AIQY3a/F4mw).

Environment Noise Elimination will pass on some unnecessary data Noise Elimination . It could be recreated in the pictures with a few additional lines, high contrast spots, pictures with checkerboard impact, spread edges in the picture, non-uniform enlightenment, and obscured edges if assume either that the camera or item is moving [(Ohyama and Jung 2020)](https://paperpile.com/c/AIQY3a/THla). To proceed with picture examination with Environment noisy pictures care should be initiated to comprehend the effect of noise by the methodology which was explained earlier.[(Vijayakumari B. 2021).](https://www.igi-global.com/chapter/noise-removal-with-filtering-techniques/262071). Pictures are frequently debased by noises. Noise is caused during the extraction of the picture, transmission, and so on. The Environment noise elimination is a significant assignment in picture handling[(Chui and Chen 2013)](https://paperpile.com/c/AIQY3a/BKKL). Overall the outcome of the noise elimination process impacts the nature of the picture-handling methods[(Bazzichelli 2021)](https://paperpile.com/c/AIQY3a/eJ1B) . A few procedures for the elimination of Environment noise are deeply rooted in a variety of picture handling. The idea of the commotion evacuation issue relies upon the kind of noise defiling the picture . These algorithms are used in natural real time images.([Abdalla Mohamed Hambal et al. 2015)](https://www.ijsr.net/archive/v6i3/25031706.pdf).

Noise in the picture is an inescapable incidental effect happening because of extraction of the image, all the more essentially perceived as imperceptible, yet unavoidable fluctuations. In a computerized camera,The reason the image becomes noisy is because of skew in the light entering the focal point with sensors[(College Board 2008)](https://paperpile.com/c/AIQY3a/hXPH) . Even if the unnecessary data isn't as obvious in an image, there will surely be some type of picture noise. Every type of electrical device picks up and transmits some commotion to what it is producing [(Coşkun et al. 2020)](https://paperpile.com/c/AIQY3a/0aIq). The images are contaminated by driving turbulence during the channel transmission due to the loud channels.

[Dr. Uday Pratap Singh et al., 2013](https://www.researchgate.net/publication/299629847_Noise_Removal_Using_First_Order_Neighbourhood_Mean_Filter) says that noise Elimination of noise is one of the main parts to get a unique picture from a profoundly corrupted picture. The picture can be debased with the noise during transmission from the noisy channels, sensors, or because of a few ecological circumstances. This makes the picture outwardly unkind [(Vergara-Villegas et al. 2022)](https://paperpile.com/c/AIQY3a/PBaM). Impulsive noises might happen during transmission which exceptionally corrupts the picture

Over the past 5 years, nearly 300 research works were available on GS (Google Scholar) website and approximately 150 research papers were available in sciencedirect based journals with different types of filtering approaches. Compared to the outcome of the other filtering approaches, the novel Kalman Filter eliminates the noises from the real-time images with superior accuracy [(Roman-Rangel et al. 2021)](https://paperpile.com/c/AIQY3a/O8N9). The major intention of this present research work is to eliminate the noises from real-time images using filtering approaches with an exact accuracy rate.

**MATERIALS AND METHODS**

This examination was created and designed at SIMATS, Saveetha School of Engineering, Image Processing Laboratory (Saveetha Institute of Medical and Technical Sciences). There are two different sorts of groups in the proposed noise deletion mechanism. The novel Kalman Filter is used for group 1, and the Mean Filter is used for group 2. Using the novel Kalman Filter and Mean filter,evaluated many times by 150 sample sizes. After the gathering of the image database, repetitive and excessive portions of the images were unconcerned by filtering and data cleaning processes. Then, it is associated with the concerned real data sets, and the accuracy of the novel Kalman Filter and Mean filter is calculated and compared.

The real-time images are collected from various domains and applied in this present research work for the investigational process. It uses a MATLAB tool for developing the proposed filtering system. Among the different types of software tools, MATLAB is one of the most ordinarily used tools for developing and assessing the performance of the filters. It contains a large number of library functions and numerous tools that are used for whole processes connected to the filtering model.

**NOVEL KALMAN FILTER**

Filtration with the novel Kalman Filter is an unsupervised filtering calculation specific to sensor information, which changes the presently estimated sensor esteem by thinking about the past sensor information, for instance, to eliminate the noise in the values that are measured. Since it can give values nearer to the exact values of the sensor (without noise) than the easiest values that are measured, one frequently utilizes a novel Kalman Filter to eliminate the noise of sensor information or to foresee the following sensor values. Kalman separates work into two stages: detection and update. In the first detection step, it appraises the following worth to be estimated from the ongoing sensor in light of the past sensor information. Then, in the update step, the assessed value is refined in the detection step utilizing the values that are measured right now, to get a value nearer to the exact one.

Specifically, when the novel Kalman Filter is utilized for sound decrease, it plans to limit the mistake between the exact worth of having noise-free and the correct value. Since the methodology of Kalman filtering utilizes past information recursively, one can expect more precise outcomes than a separating strategy dependent just upon approaching estimations. Furthermore, as it processes new estimation information rapidly, it is appropriate for taking care of constantly produced sensor information.

**Pseudo code**

input-Coaching and data verification .

output-A classification of records that have been tested.

1. The dataset has been loaded.

2. Randomly selected samples from the dataset were checked out.

3. The goal variables have been set.

4. A classifier that was entirely created using the coaching dataset.

5. Predicted dataset for checking out.

6. Classifier evaluation.

**MEAN FILTER (MF)**

A clear, intuitive, and simple method for smoothing images is mean separation, which involves, for instance, reducing the power variation between one pixel and the next. It is typically applied to remove noise from images. To replace each pixel's value in a picture with that of its average neighbors, which includes itself, is the basic idea behind mean separation. This eliminates pixel values that aren't indicative of their surrounding items. Usually, mean separation is regarded as a convolution filter. Like other convolutions, it is built on a part that takes into account the size and shape of the

In order to "smooth" images, average (or mean) filtering reduces the power variation between adjacent pixels. The usual filter operates by moving pixel-by-pixel through the image, replacing each value with the typical benefit of adjacent pixels, incorporating that as well. A few issues are to be expected: A single pixel with a very unrepresentative measurement can actually affect the average value of the many pixels around it. The filter introduces additional characteristics for pixels on the edge when the channel region is riding an edge, obfuscating that edge. If the outcome is supposed to have sharp edges, then this can be a problem.

The benefits of the novel Kalman Filter are: (I) it increments exactness rate; (ii) it saves picture edge and time-series low-recurrence genuine sign (iii) it is reasonable for ongoing pictures.

**Pseudo code**

# input-Data for training and testing .

# outputs-A category of information testing and accuracy.

# 1. A trained dataset has been used.

# 2. Calculated the predictor variables' infer and extensive deviation.

# 3.Continuously determined the probability of the predictor variable using gauss density

# Equation. until all predictor variables' probabilities are computed.

# 4. Determine the probability for each class.

# 5. The highest likelihood was attained.

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# **STATISTICAL ANALYSIS**

Statistical software tool IBM SPSS with the commercial version 26.0 to identify the value of SD (Standard Deviation), mean deviation data, significance point value and also drawing the graphical indications, etc. The SPSS tool was inclined in the current research task to investigate concerns given the data set. Group statistics measurements and self-determining sample tests were focused on the experimental results and the pictorial representation was created for two different graphs with two different kinds of features under the specific trial phase.

Datasets for training and testing are selected for the database. The training dataset is established by reclaiming the test dataset from the real dataset as long as 400 images data as a whole.

**RESULTS**

MATLAB tool is used to examine the given real-time data and the accuracy rate is assessed among Kalman and Mean filters. For real-time datasets, the proposed novel Kalman Filter provides a better accuracy value than the Mean filter. The accuracy rate of the novel Kalman Filter 91.57 and the Mean filter 87.57% illustrates group statistics based on the real-time dataset of the suggested research work.

Table 1. Comparison of prediction of accuracy between novel kalman Filters and mean filter. The novel kalman Filters achieved an accuracy of 91.57% compared to mean filters having 87.57%. It shows that the novel kalman Filters performed significantly better than the mean filter For Natural Noise Removal in Real Time Images . The precision and execution of novel kalman filters were found to be significantly higher than those of mean filter.This indicates that novel kalman filters are a better choice than mean filters for this particular dataset and task.

Table 2 Group information displaying the mean, popular deviation, and fashionable error imply values for the two algorithms, novel kalman filter and mean filter algorithm - with 10 sample sizes. The Performance of novel kalman filter and mean filter on the noise Detection and Removal in real time Images is implemented for the given dataset. The results show that the novel kalman filter has a standard deviation of 2.619 and a standard error mean of 0.828. For mean filter, with a standard deviation of 0.1806 and a standard error mean of 0.918.

Table 3 It shows the results of the 2-tailed significance test, which indicates that the difference in accuracy between the two algorithms is statistically insignificant. The 2-tailed significance value of less than 0.05 (p< 0.05) supports the hypothesis that the novel kalman filter is a better choice than the mean filter for this dataset and task.

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# **DISCUSSION**

The Mean filter is used in the former research processes, with a mean rate of accuracy value of 87.91%. The novel Kalman Filter is developed, which has a mean accuracy rate of 91.57%.The utilization of advanced pictures is famous and draws in numerous areas and applications including clinical, object recognition, vegetation, and so on[(You and Kaveh 2000)](https://paperpile.com/c/AIQY3a/t1CG). The information which is gathered by cameras generally contains unwanted data and unsettling influences.Noises in the image are unwelcome fine artifacts of the captured image[(Chui and Chen 2013; Vaseghi 2013; Deisenroth, Aldo Faisal, and Ong 2020)](https://paperpile.com/c/AIQY3a/BKKL+08L7+MWDZ) Noise is a prominent characteristic of the picture's grains and is an erratic variation of the picture's strength [(Chui and Chen 2013; Vaseghi 2013; Deisenroth, Aldo Faisal, and Ong 2020)](https://paperpile.com/c/AIQY3a/BKKL+08L7+MWDZ). It usually results from the effects of either the nuclear power of intensity inside picture sensors or the photonic idea of the fundamental physical science of light[(Khmag et al. 2018)](https://paperpile.com/c/AIQY3a/ZNUs). Noise suggests that rather than the accurate pixel values derived from the picture, the pixels in the image display varying power levels[(Chui and Chen 2013; Vaseghi 2013; Deisenroth, Aldo Faisal, and Ong 2020)](https://paperpile.com/c/AIQY3a/BKKL+08L7+MWDZ). Therefore, manipulating the images in a frustrated manner would have a profound impact on the results and character of the image Prior to manipulating the photos, denoising is done [(Bioucas-Dias and Figueiredo 2010)](https://paperpile.com/c/AIQY3a/97eb) .

propose a new strategy for suggesting the estimation of noise for Kalman filtering, which is one of the most delegated filtering methods[(Chui and Chen 2013; Vaseghi 2013)](https://paperpile.com/c/AIQY3a/BKKL+08L7). It rectifies incorrect values of info sensor information, and its filtering execution changes relying upon the information noise boundaries. Specifically [(Senjyu et al. 2021)](https://paperpile.com/c/AIQY3a/ssNO), if the parameters of noise decided because of the client's experience are wrong, the exactness of the novel Kalman Filter might be decreased fundamentally [(Chui and Chen 2013; Vaseghi 2013; Deisenroth, Aldo Faisal, and Ong 2020)](https://paperpile.com/c/AIQY3a/BKKL+08L7+MWDZ). Based on this examination, the author tends how to decide the estimation noise difference, a significant information boundary of Kalman filtering, by breaking down past sensor information and how to utilize the assessed clamor to further develop the filtering exactness[(Herraiz-Martínez et al. 2021)](https://paperpile.com/c/AIQY3a/ZYpm).

[S. Rakshit, et al., 2007](https://www.isical.ac.in/~ash/Rakshit-pr-07.pdf) present a novel strategy for mean filtering that decreases the expected number of increments and disposes of the requirement for division out and out[(Obaidat 2019)](https://paperpile.com/c/AIQY3a/wWof). The time decrease is accomplished utilizing fundamental store-and-bring tasks and is independent of the picture or neighborhood size[(Chui and Chen 2013)](https://paperpile.com/c/AIQY3a/BKKL). This strategy has been tried on an assortment of grayscale pictures and neighborhood sizes with the outcomes[(Daimi et al. 2021)](https://paperpile.com/c/AIQY3a/CfuT). These outcomes show that the overall time necessity lessens with expansion in picture size[(Senjyu et al. 2021)](https://paperpile.com/c/AIQY3a/ssNO). The technique's proficiency additionally improves fundamentally with expansion in area size in this manner making it progressively valuable while managing enormous pictures[(Vaseghi 2013)](https://paperpile.com/c/AIQY3a/08L7). A better filter calculation for the rebuilding of the dark-scale picture that is profoundly defiled by the noise of salt and pepper is proposed by [Sunil Malviya, et al., 2014.](https://www.semanticscholar.org/paper/Image-Enhancement-Using-Improved-Mean-Filter-at-Low-Malviya-Amhia/a977b00f4e25c8ed6304ef0e5819b6e80d7d6f9d)

**CONCLUSION**

In the image noise detection and removal, the proposed Novel Kalman Filters outperforms the existing Mean Filter in terms of accuracy (91.57% Vs 87.91%). From the simulation results and statistical analysis, the Novel Kalman Filters is recommended to use in the field of image processing for sensitive information.

# **DECLARATIONS**

**Conflicts of Interest**

The author declares no conflicts of interest.

# **Author’s contribution**

Author KD was involved in data collection, data analysis, and manuscript writing. Author GK was involved in conceptualization, data validation, and critical review of the manuscript.

# **Acknowledgement**

The authors would like to express their gratitude towards Saveetha School of Engineering and Saveetha Institute of Medical And Technical Sciences (formerly known as Saveetha University) for providing the necessary infrastructure to carry out this work successfully.

**Funding**

We thank the following organizations for providing financial support that enabled us to complete the research.

1. Sri cuba innovations pvt .ltd.
2. Saveetha School of Engineering
3. Saveetha University.
4. Saveetha Institute of Medical and Technical Sciences.

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**TABLES AND FIGURES**

**Table 1**. Comparison of prediction of accuracy between novel kalman filter and mean filter. Novel kalman filter achieved an accuracy of 91.57% compared to the mean filter having 87.91%.

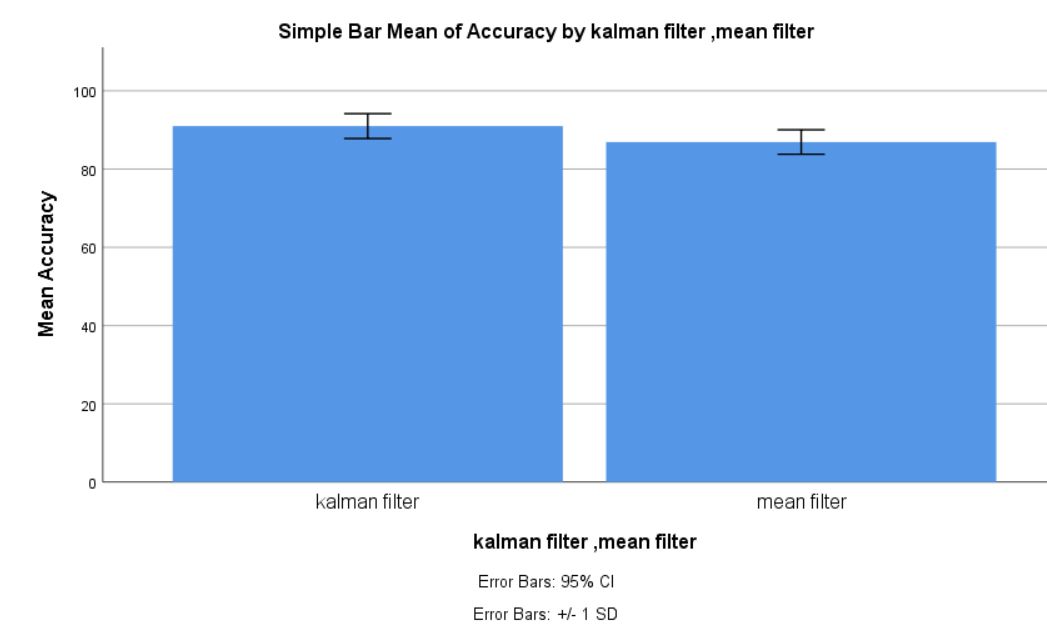
| **Sl.no** | **Novel kalman filter** | **Mean filter** |
| --- | --- | --- |
| 1 | 91.57 | 87.91 |
| 2 | 90.40 | 86.78 |
| 3 | 89.80 | 85.56 |
| 4 | 88.56 | 84.93 |
| 5 | 87.98 | 83.38 |
| 6 | 86.59 | 82.05 |
| 7 | 85.98 | 81.49 |
| 8 | 84.94 | 80.87 |
| 9 | 82.99 | 79.96 |
| 10 | 81.56 | 78.50 |

**Table 1.**Mean, standard deviation, and standard error mean for the two groups tested, novel Kalman Filter and mean filter- are given below**.**

| **Algorithm** | | **N** | **Mean** | **Standard Deviation** | **Standard Error Mean** |
| --- | --- | --- | --- | --- | --- |
| Accuracy | Kalman filter | 10 | 91.57 | 2.619 | .828 |
| Mean filter | 10 | 87.91 | 0.18062 | .918 |

**Table 2.**We found the mean and variance value by using Levene’s test for equality of variance and t-test for equality means. By assuming equal variance and unequal variance value.And accuracy for both of them **.**

|  | | **Levene’s test for equality of variables** | | **T-test for Equality of means** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **F** | **Sig** | **t** | **df** | **Sig (2-tailed)** | **Mean Difference** | **Std. Error Difference** | **95% confidence interval of the Difference** | |
| **Lower** | **Upper** |
| **Accuracy** | Equal variances assumed | .383 | .544 | 3.586 | 18 | 0.005 | 4.435 | 1.237 | 1.837 | 7.033 |
| Equal variances not assumed |  |  | 3.586 | 18 | 0.005 | 4.435 | 1.237 | 1.835 | 7.035 |



**Graph**

**Fig. 1.** Comparison of novel Kalman Filter and mean filter in terms of mean accuracy and . The mean accuracy of the mean filter is better than the novel Kalman Filter and the standard deviation of the mean filter is slightly better than the Kalman filter. X Axis: mean filter Vs novel Kalman Filter Y Axis: Means Accuracy of Detection ±1 SD.